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Memorandum

To: Christie McOmber, P.E.
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From: John Sharkey
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Date: October 10, 2008

Subject: Curves N. of Tracy; STPHS 227-1(10)2; CN 5303
Geotechnical Supplemental Report No. 1 (Activity 468)
Revised (7/17/2008) Alignment

The Geotechnical Section has completed analyses on the revised project alignment. The intent of this supplemental report is to replace the original report dated March 7th, 2008, in it's entirety.

1.0 INTRODUCTION

1.1 Purpose: Great Falls Design modified the previous project alignment in order to avoid likely short- and long-term difficulties associated with very soft in-situ soils, high water tables, and potential hydraulics issues. This report discusses findings of the follow-up field investigation and gives geotechnical recommendations for the revised alignment.

1.2 Location: The project is located in Cascade County on Route 227 southeast of Great Falls. The modified alignment begins approximately ¼ mile north of the BNSF railroad crossing and extends southerly approximately 1.5 miles. From the north, the proposed alignment follows the existing alignment for approximately 1700 feet, bears southeast through an agricultural field, cuts into the hill, then rejoins the existing alignment on the south side of the hill. This new alignment reduces the overall project length by approximately 1 mile.

1.3 Geology/Soil Conditions: The northern and southern extents of the revised alignment will be constructed on Quaternary Glacial Lake Deposits consisting primarily of lean clay with lesser amounts of silt and sand. The central portion of the project will require construction of a large cut and backslope in the Cretaceous Kootenai formation comprised of sandstone, shale, mudstone and siltstone/claystone.

2.0 SUBSURFACE INVESTIGATION:

Drilling was conducted with a CME 1050 Drill Rig using 8 inch hollow-stem augers and NQ core barrel. Sampling and testing consisted of Shelby Tube samples, split spoon and core samples. An additional 12 borings ranging in depth from 14' to 65' were drilled to evaluate the newly proposed alignment in August and September, 2008.

Laboratory analyses of the materials collected during drilling included soils classification, consolidation, and in-situ moisture content. Boring logs and a summary of laboratory testing are attached.

Subsurface soils encountered during drilling in the northern and southern lowland areas of the project consisted soft to very stiff lean sandy clays and lean silty clays, and some silt. The borings located on the slopes and top of the hill revealed durable, fractured sandstone generally within the first few feet of the surface. However, in most areas, the sandstone is underlain by moderately to completely weathered siltstone and shale. These siltstone and shale layers are often bentonitic, often decomposed to a clayey material, and will generally make poor subgrade material.

Groundwater was encountered in the 3 northern-most borings only (#'s 14, 15, and 15a), and ranged in depth from 13 to 22 feet below ground surface. Subsurface soils in the lowland areas were generally moist to wet despite the fact that drilling was conducted during the late summer. The borings located in the central and southern portions of the project did not intersect the groundwater table.

3.0 DISCUSSION AND RECOMMENDATIONS:

3.1 Embankment Construction, Beginning of Project to Station 40+40 (see logs 14, 15, 15A & 16): The subgrade consists of soft to very stiff, sandy and silty clay (A-6 to A-7-6), and lesser silt (A-4) soils. Though subgrade soils within this section are considered poor, they are of considerably better quality than those encountered during the investigation for the previous alignment.

The revised profile indicates a maximum of about 10 feet of fill in this section. Based on settlement analyses it is estimated that up to approximately 6 inches of settlement will occur in those areas with the greatest fill. Analyses also estimate that the time required for 90% consolidation is up to 6 months. In order to minimize the detrimental effects of differential settlement on pavement performance, it is recommended that embankment be allowed to settle as long as practical prior to paving. See cross section at Sta. 30+00 for an example of an area where differential settlement could cause pavement damage. Ideally, the embankment should be constructed near the end of the construction season allowing a minimum of 6 months prior to the construction of the surfacing section. We recommend that this be specified in the contract.

Proposed embankment fill slopes of 6H:1V are expected to be stable. Major construction and long-term maintenance difficulties are not anticipated within this region of the project if constructed by preloading and allowing for settlement.

3.2 Cut Slopes, Station 40+40 to 59+50, Cut Slope (see logs 9, 10, 16, 17, 17A, 18, 19, 19A & 20): Near surface material in this section generally consists of between 1 to 8 feet of silty clay or sandy silt topsoil with sandstone boulders. In most areas, the topsoil is underlain by slightly weathered, moderately hard to hard sandstone with fracture spacing from 1 to 15 inches. The sandstone layer is variable in thickness between approximately 4 and 40 feet, and is often interbedded with weathered shale and siltstone/claystone. Weathered bentonitic shale and siltstone/claystone underlies the sandstone layer. This formation material exhibits varying degrees of decomposition, and samples recovered were often very soft, granulated, and/or completely weathered to clay.

Adjusting the profile in order to keep the grade within the upper, more durable sandstone is not feasible due to the highly variable elevations of the layer. However, if locally derived, the crushed sandstone should perform well as base. Also, blending the sandstone with the poorer quality formation material obtained from the cut should improve drainage characteristics and increase long-term performance within the fill sections.

It is recommended that cut slopes be 2H:1V or flatter. It is our opinion that most of material to be cut should be excavatable without blasting, although some horizons, especially within the sandstone layer may be resistant to ripping and that blasting may be required. A blasting special provision is attached.

3.3 Combination Cut and Fill Slopes, Station 59+50 to 67+50 (see logs 9, 10, 19, 19A, 20 & 21): The subsurface within this section will vary along the width of the profile. Subsurface soils beneath the cut sections will vary from silty clay with boulders to sandstone to weathered shale and siltstone as described above. In contrast, subsurface soils underlying the fill sections consist of very soft to stiff, sandy lean clay and fat clay (A-6 to A-7-6(40+)), and lesser silt (A-4) soils.

The revised alignment within this region traverses across the side of the hill and necessitates combination cut and fill slopes. The proposed embankment fill slopes of 4H:1V or flatter are expected to be stable. In many areas within this section, the existence of the abandoned railroad bed will add to the overall global slope stability through a buttressing effect.

It is also recommended for this reach that cut slopes be 2H:1V or flatter. See paragraph 3.2 above regarding ripping and blasting.

The profile indicates an approximate maximum of 15 feet of fill at station 62+00. Based on settlement analyses it is estimated that up to 12 inches of settlement may occur in those areas with the greatest fill. Here, settlement is expected to occur more rapidly compared to that near the beginning of the project since subsurface soils have somewhat lower moisture contents and ground water is deeper. However, because of the differing foundation materials beneath the partial cut - partial fill profile within this section, allowing the embankment time to settle is again recommended to reduce the potentially detrimental effects of differential settlement. Again, it is recommended that the embankment should be constructed near the end of the construction season, and 6 months should be allowed for consolidation to occur prior to the construction of the pavement.

3.4 Embankment Construction, Station 67+50 to End of Project (see logs 11, 12, 13 & 22): Similar to the fill section on the north end of the project, the subsurface within this section consists of very soft to stiff, sandy and silty clay (A-6 to A-7-6), and sandy silt (A-4) soils.

The revised alignment parallels the existing PTW and an abandoned railroad bed, then rejoins the existing roadway at station 70+80. The profile indicates an approximate maximum of 14 feet of fill in this section. Based on settlement analyses it is estimated that up to 9 inches of settlement may occur in the thicker fill areas. Differential settlement damage would be less of an issue here than the remainder of the project but it is still recommended that the fill be allowed to settle 6 months before paving. This would be especially true where the new alignment is off the PTW.

Proposed outslope angles of 5H:1V are expected to be stable, and global stability will again benefit from the buttressing effect of the abandoned railroad bed. Major construction and long-term maintenance difficulties are not anticipated within this region of the project.

3.5 Embankment Construction, General: Depending on the method of excavation employed, material obtained from the cut may be contain rocks and boulders of substantial size. If the materials excavated from the cut are to be used for embankment fill, crushing will likely be required to ensure that construction can occur in accordance with the standard specifications. It is recommended that in the top 2 feet of embankment fill that the maximum particle size be limited to 6 inches to ensure better compaction and more uniform subgrade conditions. A Special Provision is attached addressing this issue.

3.6 Shrink/Swell Recommendations: Based on an evaluation of the soil and rock samples collected in our borings, it appears that most of the material excavated from the cut area will be rock, although highly weathered in some cases. We recommend that a shrinkage factor of 10 to15 percent be used for this material when used as embankment fill.

4.0 LIMITATIONS Professional judgments and recommendations are presented in this report. They are based partly on evaluation of the technical information gathered, partly on historical information available, and partly on the Geotechnical Section's general experience with subsurface conditions in the area. The Geotechnical Section does not guarantee the performance of the project in any respect other than that the engineering work and the judgment rendered meet the standards and care of the profession. It should be noted that the borings may not represent potentially unfavorable subsurface conditions between borings. If, during construction, soil or rock conditions are encountered that vary from those discussed in this report or historical reports, or if alignment and grade and/or configurations change, the Geotechnical Section should be notified immediately in order that it may evaluate effects, if any, on our recommendations. The recommendations presented in this report are applicable only to this specific site. These data are not to be used for other purposes.

Original: Geotechnical Project File

Copies: Michael P. Johnson, District Administrator- Great Falls
Stephen J. Prinzing, P.E., D.E.S.S.- Great Falls
Kurt Marcoux, P.E. - Hydraulics, Helena
Jake Goettle, P.E. – Construction, Helena
Doug Wilmot, P.E. Great Falls Construction
Geotechnical Correspondence File (without attachments)

Attachments:
- Boring Location Map
- Boring Log Keys (Soil and Rock)
- Summary of Soil Index Test Results
- Boring Logs – Revised Alignment (Note: Boring Logs 11, 12 & 13, from previous field investigation, included for reference)

Embankment Particle Size
Blasting